(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 937 913 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
25.08.1999 Bulletin 1999/34

(51) Int. Cl.[6]: F16H 61/00

(21) Application number: 99101752.6

(22) Date of filing: 11.02.1999

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 18.02.1998 JP 3604698

(71) Applicant:
NISSAN MOTOR COMPANY, LIMITED
Yokohama-shi, Kanagawa 221-0023 (JP)

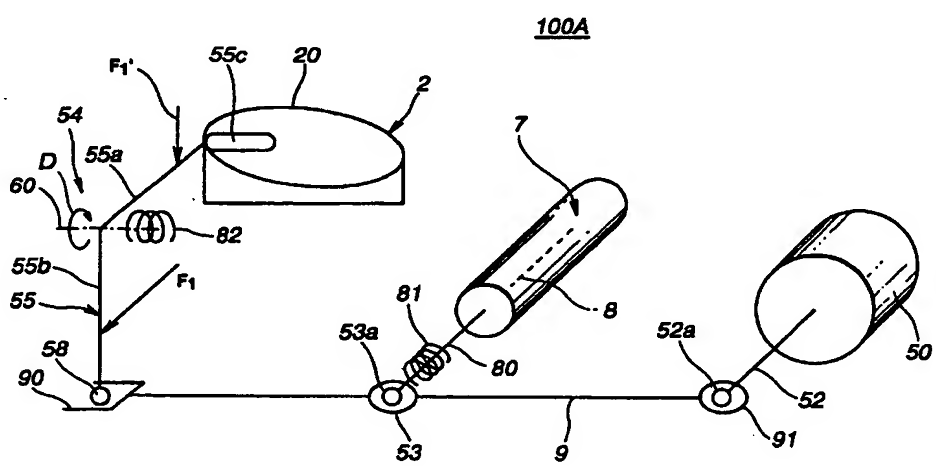
(72) Inventor: Sakai, Hiromasa
Yokosuka-shi, Kanagawa 237-0076 (JP)

(74) Representative:
Grünecker, Kinkeldey,
Stockmair & Schwanhäusser
Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

(54) Speed control device of toroidal type continuously variable transmission

(57) A pivotal feedback link (55) has at one end thereof a follower member that is slidably put on a work surface (20) of a precess cam (2) actuated by a trunnion (108) of a toroidal type continuously variable transmission (1000). A speed control valve (7) has a spool (8). The spool (8) is moved for feeding a hydraulic actuator (116A) of the transmission with a hydraulic pressure to control the trunnion (108). An electric actuator (50) has an output member (32). A speed change link (9) is arranged to which the other end of the pivotal feedback link, the spool (8) of the speed control valve (7) and the output member (52) of the electric actuator (50) are connected through first, second and third articulated members (55a,55b,55c) respectively. A spring member (82) is connected with the pivotal feedback link (55) at a position between the first articulated member (55a) and the follower member to bias the pivotal feedback link (55) in a direction to press the follower member (55c) against the work surface (20) of the precess cam (2) so that the biasing force of the first biasing member (82) does not affect the moment of rotation of the speed change link (9) about the first articulated member (55a).

FIG.3



EP 0 937 913 A2

Fig. 4 is a partially cut side view of a speed control device of a second embodiment of the present invention;

Fig. 5 is a schematic plan view showing only essential parts employed in the speed control device of the second embodiment;

Fig. 6 is a schematic plan view of a speed control device of a third embodiment of the present invention, which is taken from a bottom of an associated continuously variable transmission;

Fig. 7 is a schematic front view of the speed control device of the third embodiment;

Fig. 8 is a view similar to Fig. 3, but showing a fourth embodiment of the present invention;

Fig. 9 is a view similar to Fig. 3, but showing a fifth embodiment of the present invention; and

Fig. 10 is a sectional view of one known toroidal type continuously variable transmission to which the speed control device of the present invention is practically applicable.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0013] In the following description, directional terms such as, right, left, upper, lower, rightward, leftward, upward, downward and the like are to be understood with respect to the drawing or drawings on which the objective part or parts are illustrated.

[0014] Before making a detailed description on the present invention, one known toroidal type continuously variable transmission to which the speed control device of the invention can be practically applied will be described with reference to Fig. 10 for clarification of the invention.

[0015] As is shown in the drawing, the toroidal type continuously variable transmission 1000 comprises input and output cone discs 102 and 104 which are arranged on a common rotation axis "O_1". Denoted by numerals 106 and 106 are friction rollers (or power rollers) which are each operatively interposed between the input and output cone discs 102 and 104. The friction rollers 106 and 106 are arranged to face each other with the axis "O_1" placed therebetween, as shown. That is, each friction roller 106 is put in a toroidal space defined by both the input and output cone discs 102 and 104, while frictionally contacting with these discs 102 and 104. The friction rollers 106 and 106 are rotatably supported by respective trunnions 108 and 108 through respective eccentric shafts 110 and 110. The input and output cone discs 102 and 104, the two friction rollers 106 and 106 and the trunnions 108 and 108 constitute an essential portion of a toroidal power transmission unit.

[0016] In a double cavity toroidal type continuously variable transmission, two, that is, front and rear toroidal power transmission units are employed, which are coaxially arranged o the axis "O_1" with their output cone discs 104 and 104 connected in a back-to-back connecting manner.

[0017] As is seen, the trunnions 108 and 108 have respective upper ends connected through an upper link 112 and respective lower ends connected through a lower link 114. The connection of these parts is so made that each trunnion 108 can pivot between a neutral position as shown in Fig. 10 wherein a rotation axis "O_2" of the friction roller 106 intersects the rotation axis "O_1" of the input and output cone discs 102 and 104 and an offset position wherein the trunnion 108 is inclined toward a pivot axis "O_3" of the friction roller 106 which intersects the rotation axis "O_2" at right angles. The trunnion 108 pivots about the pivot axis "O_3".

[0018] For carrying out the above-mentioned offset movement, each trunnion 108 has a shaft 108d connected to a lower end thereof through a pin 108e, the shaft 108d extending in the direction of the pivot axis "O_3". Tightly disposed on the shaft 108d is a servo-piston 116a which is axially movably received in a cylinder body 118.

[0019] As is seen from the drawing, the shaft 108d of one (viz., left one in the drawing) of the trunnions 108 and 108 has a lower extension projected downward beyond a control valve body 70, to which an after-mentioned precess cam 2 is connected.

[0020] The control valve body 70 has a control valve for generating a controlled hydraulic pressure to operate the servo-piston 116a. An L-shaped link 55 is incorporated with the precess cam 2, through which an offset degree of the trunnion 108 in the direction of the pivot axis "O_3" and a rotation degree of the trunnion 108 about the pivot axis "O_3" are fed back to a speed control valve 7 (more specifically, a spool 8 of the valve 7) in the control valve body 70. That is, one end of the L-shaped link 55 acts as a follower that slidably contacts with an inclined surface 20 of the precess cam 2. The other end of the L-shaped link 55 is connected to the spool 8 through a speed change link 9.

[0021] As shown, the left shaft 108d having the precess cam 2 connected thereto and a hollow boss portion 116b of the servo-piston 116a for receiving the left shaft 108d pass through the cylinder body 118 and the control valve body 70. While, the right shaft 108d having no precess cam and a hollow shaft portion 116b of the servo-piston 116a for receiving the right shaft 108d pass through only the cylinder body 118. Each shaft 108d has at a lower end a nut 126 secured thereto to achieve a united connection between the shaft 108d and the associated servo-piston 116a.

[0022] Upon receiving a speed change ratio command, the speed control valve 7 applies the servo-pistons 116a and 116a with a hydraulic pressure corresponding to the content of the command. With this, each servo-piston 116a forces through the corresponding shaft 108d the trunnion 108 to pivot between the above-mentioned neutral position of Fig. 10 and the offset position. Due to this pivoting, each friction roller 106 is pivoted about the pivot axis "O_3" while bearing a com-

contact with the inclined surface 20 of the precess cam 2 irrespective of movement of the speed change link 9. That is, if the basing force of the torsion spring 82 is set smaller than that of the coil spring 81, separation of the follower member 55c from the precess cam 2 tends to occur, which, of course, lowers the intended feedback control.

[0037] It is to be noted that the basing force of the coil spring 81 can be set as small as possible so long as it can eliminate the play of the speed change link 9 relative to the L-shaped link 55, the spool 8 and the slider 52. The smaller biasing force of the coil spring 81 may cause the spool 8 to take a halt position due to the force of the hydraulic pressure applied thereto. However, even in this case, once a play between the speed change link 9 and the pivot pin 53a becomes zero due to movement of the link 9, the spool 8 is instantly actuated by the step motor 50 and/or the L-shaped link 55 and thus an error caused by such play can be negligible.

[0038] As has been mentioned hereinabove, in the first embodiment 100A, due to provision of the torsion spring 82, the follower member 55c of the L-shaped link 55 is assuredly and constantly contracted to the inclined surface 20 of the precess cam 2. With this, the feedback control is assuredly achieved. The biasing force of the torsion spring 82 has substantially no effect on the moment of rotation of the speed change link 9 about the articulated connection between the L-shaped link 55 and the speed change link 9. Thus, the output needed by the step motor 50 for actuating the spool 8 of the speed control valve 7 is only a force that can move the spool 8 against the smaller basing force of the coil spring 81 and the hydraulic force fundamentally applied to the spool. Accordingly, the step motor 50 employed in the invention can be of a lower-powered and thus small-sized type, unlike the case of the above-mentioned conventional speed control devices.

[0039] If desired, pillow block units may be used as the articulated connections of the L-shaped link 55, the extension part 80 of the spool 8 and the slider 52 of the step motor 50 relative to the speed change link 9. In this case, the coil spring 81 can be removed and thus the output needed by the step motor 50 can be much lowered.

[0040] Referring to Figs. 4 and 5, there is shown a speed control device 100B of a second embodiment of the present invention. In these drawings, substantially same parts are those of the above-mentioned first embodiment are denoted by the same numerals.

[0041] In the second embodiment 100B, a pull spring 83 is employed in place of the torsion spring 82 employed in the above-mentioned first embodiment 100A.

[0042] That is, as is seen from the drawings, in the second embodiment 100B, the pull spring 83 extends between the end of the speed change link 9 where the concave recess 90 is formed and a spring holder 12 which is secured to a case 10 of the associated transmission.

[0043] With the pull spring 83, the L-shaped link 55 is biased to pivot in a direction of the arrow "D" in Fig. 4, that is, in a direction to press the follower member 55c against the inclined surface 20 of the precess cam 2. That is, the articulated connection between the concave recess 90 and the ball 58 is kept pulled toward the spring holder 12 with a basing force "F_2" of the pull spring 83, as shown in the drawings, causing the follower member 55c to be pressed against the inclined surface 20 of the precess cam 2 with a basing force "F_2".

[0044] As shown in Fig. 4, in the second embodiment 100B, the inclined surface 20 of the precess cam 2 is defined in an inclined groove that has another inclined surface 21. These two inclined surfaces 20 and 21 extend in parallel with each other. As shown, a certain clearance is left between the follower member 55c and the inclined surface 21 for avoiding a scuffing between the follower member 55c and the surfaces 20 and 21 of the groove, which would occur when the precess cam 2 is inevitably tilted during torque transmission between the input and output cone discs 1 and 2 (see Fig. 10).

[0045] In the second embodiment 100B, substantially same advantages as those of the above-mentioned first embodiment 100A are obtained. That is, also in this second embodiment 100B, the biasing force of the pull spring 83 has substantially no effect on the moment of rotation of the speed change link 9 about the articulated connection between the L-shaped link 55 and the speed change link 9 because the point of application of the basing force "F_2" is very close to the ball 58.

[0046] Referring to Figs. 6 and 7, there is shown a speed control device 100C of a third embodiment of the present invention.

[0047] In this third embodiment 100C, a torsion bar 61 is employed in place of the torsion spring 82 employed in the first embodiment 100A.

[0048] That is, as is seen from the drawings, in the third embodiment 100C, the torsion bar 61 has a right end fixed to a projection 73 of the valve body 70 through a bolt 74. The torsion bar 61 has a left portion that passes through the bracket 72, the hollow member 57 and the bracket 71. As is seen from Fig. 7, a connecting pin 62 is installed in the hollow member 57 to connect the torsion bar 61 to the hollow member 57.

[0049] With the torsion bar 61, the L-shaped link 55 is biased to pivot in a direction of the arrow "D" in Fig. 7, that is, in a direction to press the follower member 55c against the inclined surface 20 of the precess cam 2. That is, the articulated connection between the concave recess 90 (see Fig. 7) and the ball 58 is kept pulled toward this side in Fig. 7 causing the follower member 55c to be pressed against the inclined surface 20 of the precess cam 2 with a certain biasing force.

[0050] In the third embodiment 100C, substantially same advantages as those of the above-mentioned first embodiment 100A are obtained. That is, also in this

valve.

7. A speed control device as claimed in Claim 1, in which said pivotal feedback link is arranged between said speed control valve and said electric actuator.

8. A speed control device as claimed in Claim 1, further comprising a second biasing member that is connected with said speed change link to bias the same in a direction away from the other end of said pivotal feedback link, the spool of said speed control valve and the output member of said electric actuator.

9. A speed control device as claimed in Claim 8, in which the biasing force produced by said second biasing member operates in a direction to assist the biasing work of said first biasing member.

10. A speed control device as claimed in Claim 2, in which said hub portion of said pivotal feedback link is secured to a hollow member that is pivotally supported through a shaft on brackets raised from said fixed portion.

11. A speed control device as claimed in Claim 3, in which said pull spring has one end pivotally connected to the other end of said pivotal feedback link and the other end pivotally connected to a spring holder secured to said fixed portion.

12. A speed control device as claimed in Claim 4, in which said torsion bar has one end fixed through a bolt to a projection formed on said fixed portion, said torsion bar extending through the hub portion of said pivotal feedback link and being connected to the same through a connecting pin, said torsion bar being pivotally supported on brackets raised from said fixed portion.

13. A speed control device of a toroidal type continuously variable transmission, comprising:

a pivotal feedback link having at one end thereof a follower member that is slidably put on a work surface of a precess cam actuated by a trunnion of said transmission;
a speed control valve having a spool, said spool being moved for feeding a hydraulic actuator of said transmission with a hydraulic pressure to control said trunnion;
an electric actuator having an output member;
a speed change link to which the other end of said pivotal feedback link, the spool of said speed control valve and the output member of said electric actuator are connected through first, second and third articulated members respectively;
a biasing member connected with said pivotal feedback link at a position between said first articulated member and said follower member to bias said pivotal feedback link in a direction to press said follower member against the work surface of said precess cam so that the basing force of said first biasing member does not affect the moment of rotation of said speed change link about said first articulated member; and
a coil spring compressed between a valve body of said speed control valve and said speed change link to bias the latter in a direction away from the other end of said pivotal feedback link, the spool of said speed control valve and the output member of said electric actuator.

14. A speed control device of a toroidal type continuously variable transmission having a feedback system, comprising:

a pivotal feedback link having at one end thereof a follower member that is slidably put on a work surface of a precess cam actuated by a trunnion of said transmission;
a speed control valve having a spool, said spool being moved for feeding a hydraulic actuator of said transmission with a hydraulic pressure to control said trunnion;
an electric actuator having an output member;
a speed change link to which the other end of said pivotal feedback link, the spool of said speed control valve and the output member of said electric actuator are connected through first, second and third articulated members respectively; and
biasing means for biasing said pivotal feedback link in a direction to press said follower member against the work surface of said precess cam so that the biasing force of said first biasing member does not affect the moment of rotation of said speed change link about said first articulated member.

FIG.2

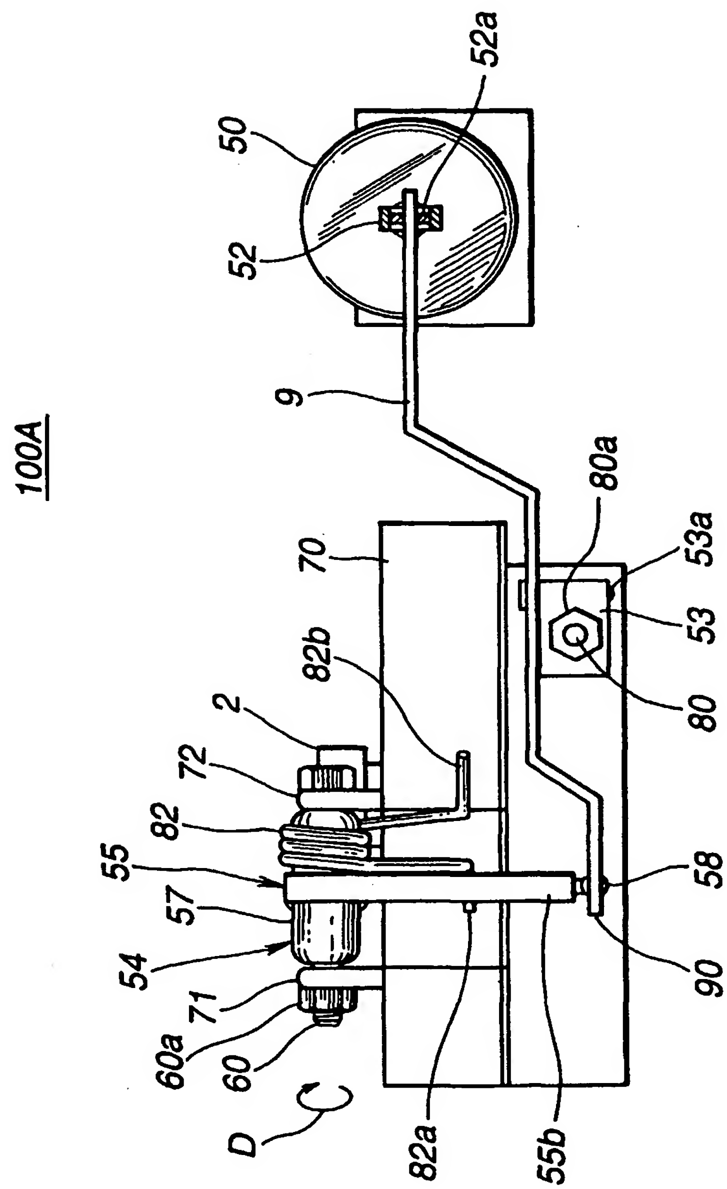

100A
50
52a
52
9
80a
53a
53
80
70
82b
2
72
82
55
57
54
71
60a
60
D
82a
55b
58
90

FIG.4

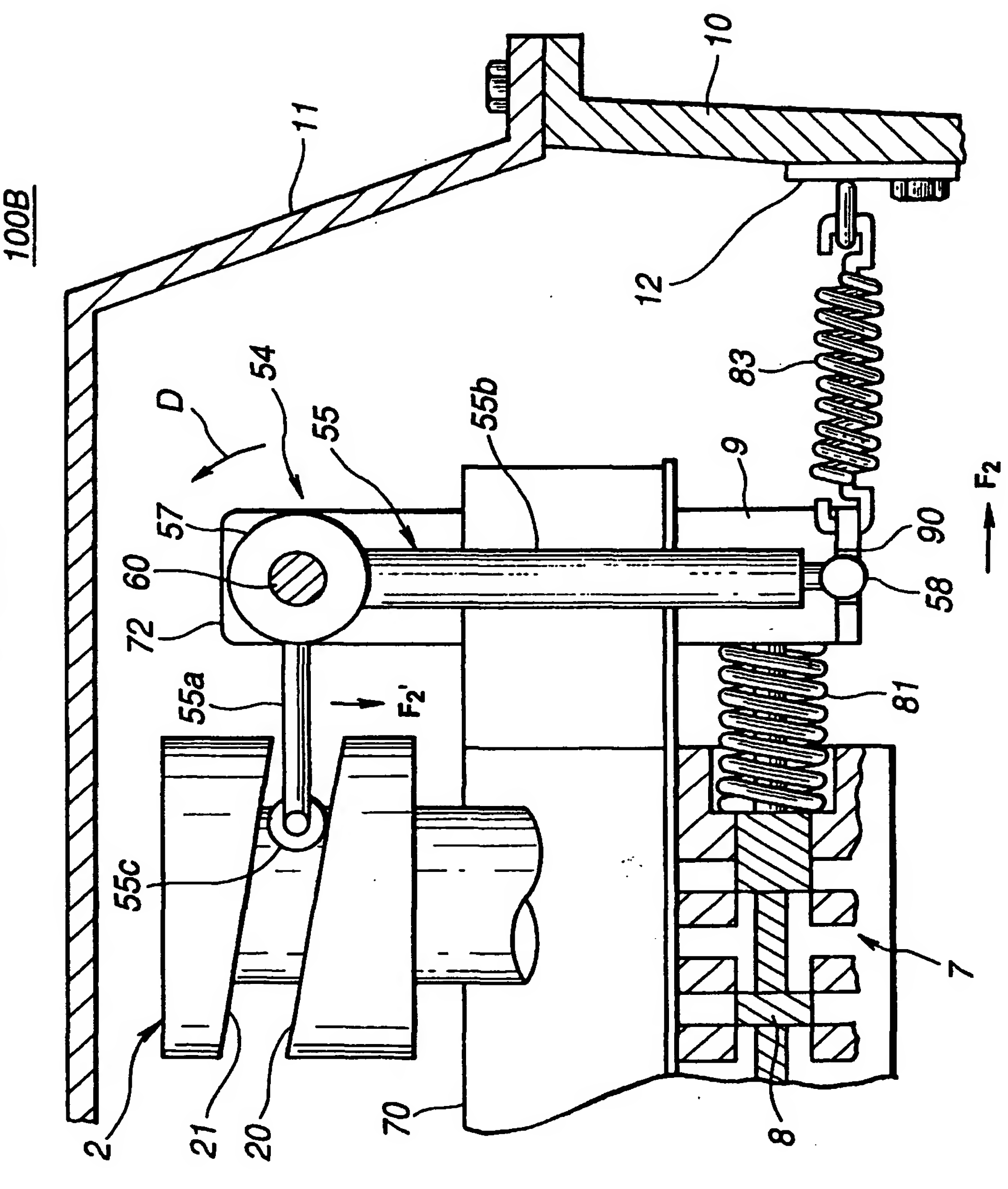

100B
11
10
12
83
9
90
58
81
7
8
70
20
21
2
55c
55a
F_2'
72
60
57
54
55
55b
D
F_2

FIG.6

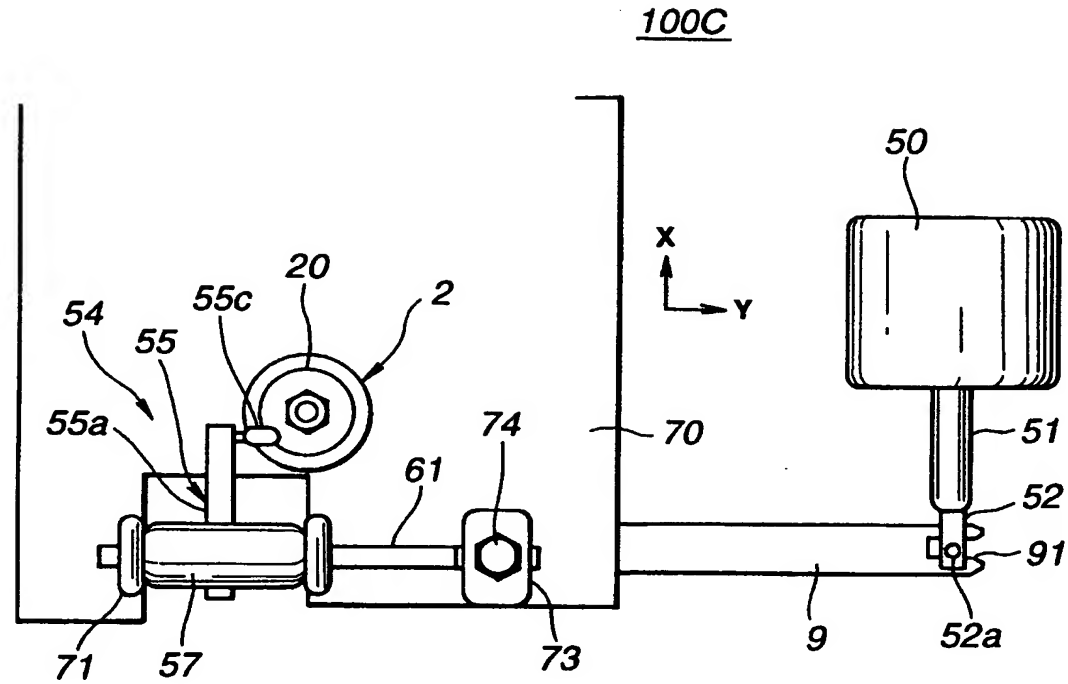

100C
50
X
Y
20
2
54
55c
55
55a
74
70
51
61
52
91
71
57
73
9
52a

FIG.7

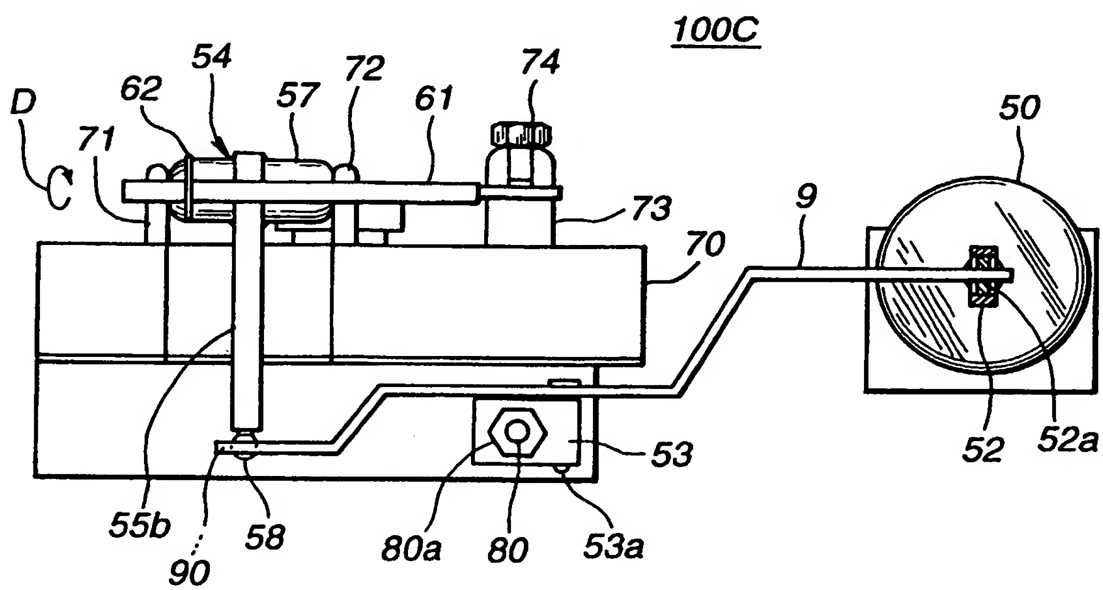
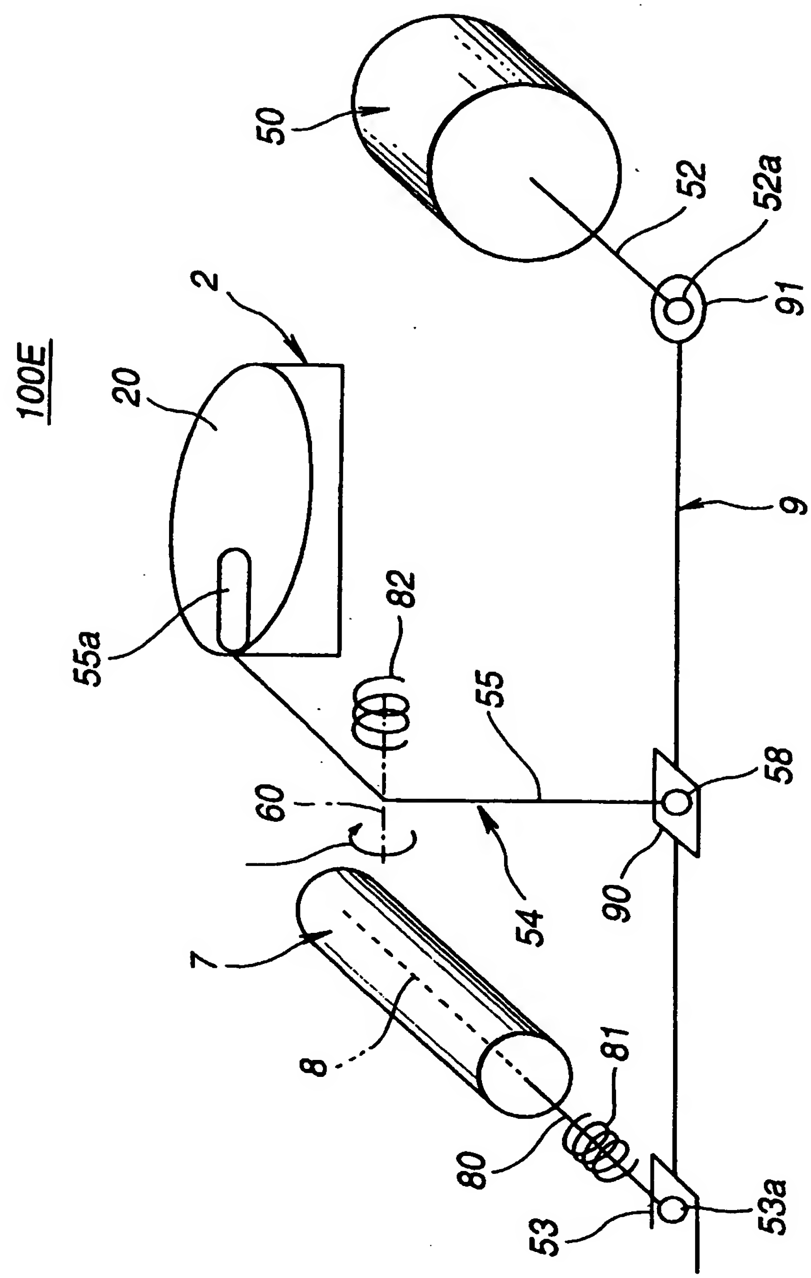

100C
54
72
74
D
62
57
61
50
71
73
9
70
52
52a
53
55b
58
80a
80
53a
90

FIG.9



(19) Europäisch s Pat ntamt
European Pat nt Office
Office uropé n d s br vets

(11) EP 0 937 913 A3

(12) **EUROPEAN PATENT APPLICATION**

(88) Date of publication A3:
11.04.2001 Bulletin 2001/15

(51) Int. Cl.[7]: **F16H 61/00**

(43) Date of publication A2:
25.08.1999 Bulletin 1999/34

(21) Application number: **99101752.6**

(22) Date of filing: **11.02.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **18.02.1998 JP 3604698**

(71) Applicant:
NISSAN MOTOR COMPANY, LIMITED
Yokohama-shi, Kanagawa 221-0023 (JP)

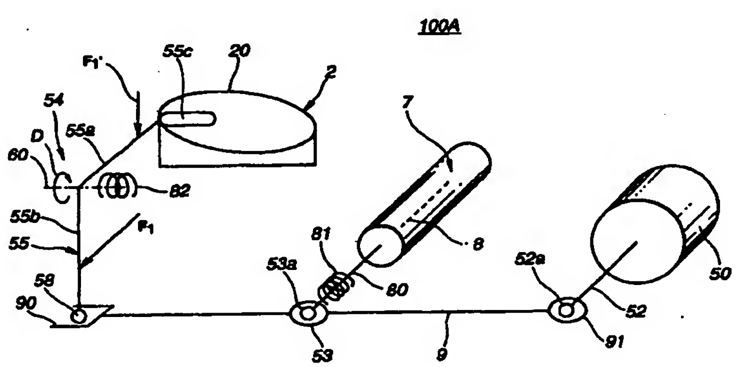
(72) Inventor: **Sakai, Hiromasa**
Yokosuka-shi, Kanagawa 237-0076 (JP)

(74) Representative:
Grünecker, Kinkeldey,
Stockmair & Schwanhäusser
Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

(54) **Speed control device of toroidal type continuously variable transmission**

(57) A pivotal feedback link (55) has at one end thereof a follower member that is slidably put on a work surface (20) of a precess cam (2) actuated by a trunnion (108) of a toroidal type continuously variable transmission (1000). A speed control valve (7) has a spool (8). The spool (8) is moved for feeding a hydraulic actuator (116A) of the transmission with a hydraulic pressure to control the trunnion (108). An electric actuator (50) has an output member (32). A speed change link (9) is arranged to which the other end of the pivotal feedback link, the spool (8) of the speed control valve (7) and the output member (52) of the electric actuator (50) are connected through first, second and third articulated members (55a,55b,55c) respectively. A spring member (82) is connected with the pivotal feedback link (55) at a position between the first articulated member (55a) and the follower member to bias the pivotal feedback link (55) in a direction to press the follower member (55c) against the work surface (20) of the precess cam (2) so that the biasing force of the first biasing member (82) does not affect the moment of rotation of the speed change link (9) about the first articulated member (55a).

FIG.3



EP 0 937 913 A3

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 10 1752

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

20-02-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 07198015 A	01-08-1995	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82